BARDIN, I.P., akademik; REZNICHENKO, V.A.

Investigating processes of reduction and slag formation during the melting of ilmenite concentrates. Titan i ego splavy no.2:23-28 '59. (MIRA 13:6)

1. Institut metallurgii AN SSSR.
(Ilmenite) (Titanium--Electrometallurgy)

REZNICHENKO, V.A.; SOLOV'YEV, V.I.

Smelting ilmenite concentrates with addition of flux. Titan i ego splavy no.2:29-34 '59. (MIRA 13:6)

1. Institut metallurgii AN SSSR.
(Titanium--Electrometallurgy) (Flux(Metallurgy))

BARDIN, I.P., akademik; REZNICHENKO, V.A.; SIDORENKO, G.D.; REVERTSOV, V.P.; LUPEYKO, V.M.

Results of enlarged laboratory investigations on the converter blowing of niobium pig iron. Titan i ego splavy no.2:35-39 '59. (MIRA 13:6)

1. Institut metallurgii AN SSSR i Institut metallurgii Ural'skogo filiala AN SSSR.
(Bessemer process) (Niobium)

AGEYEV, N.V.; REZNICHENKO, V.A.; UKOLOVA, T.P.; MODEL', M.S.

Lower titanium oxides. Titan i ego splavy no.2:64-72 '59.
(MIRA 13:6)

1. Institut metallurgi AN SSSR.
(Titanium oxides)

REZNICHENKO, V.A.; OGURTSOV, S.V.

Reduction kinetics of tetrachloride of titanium by magnesium. Titan i ego splavy no.2:82-91 '59. (MIRA 13:6)

1. Institut metallurgii AN SSSR.
(Titanium--Metallurgy) (Magnesium)

REVYAKIN, A.V.; REZNICHENKO, V.A.

Kinetics of the interaction of titanium with hydrogen. Titan i ego splavy no.2:126-132 '59. (MIRA 13:6)

1. Institut metallurgii AN SSSR.
(Titanium—Hydrogen content)

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E111/E352

AUTHORS: Karyazin, I.A. and Reznichenko, V.A. (Moscow)

TITLE: Influence of Lower Oxides of Titanium and of Calcium Oxide on the Properties of High-titanium Slags

PERIODICAL: Izvestiya Akademii nauk SSSR. Otdeleniye tekhnicheskikh nauk, Metallurgiya i toplivo, 1960, Nr 3, pp 28-34 (USSR)

ABSTRACT: High-titanium slag properties are important in smelting ilmenite concentrates in ore-reduction electric furnaces. The importance in this of the lower oxides of titanium has been demonstrated previously by the authors (Ref 1) for flux-less smelting. The present work deals with slags corresponding in composition to those of electric-furnace smelting of ilmenite concentrates with lime as a flux. The composition range covered was 19-89% TiO_2, 0-70% Ti_2O_3, 0-20% CaO with SiO_2, Al_2O_3, FeO and MgO constant at 4, 2, 3 and 2%, respectively. Synthetic slags were made by melting briquettes of the appropriate mixture of components in molybdenum crucibles in a graphite element furnace. slag temperature being measured with a tungsten-molybdenum thermocouple. Table 1 gives slag compositions and Table 2 viscosities at 1 300 - 1 600 and the temperature

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Influence of Lower Oxides of Titanium and of Calcium Oxide on the Properties of High-titanium Slags

corresponding to a viscosity of 5 poise. Viscosity for slags with 20% CaO is plotted against temperature in Figure 1, while Figure 2 gives isoviscosity lines on the various temperature planes of the phase diagram and Figure 3 the 5-poise isotherms. Figure 4 shows plots for viscosity at various CaO-contents (marked on the curves) against Ti_2O_3:TiO_2 ratio for 1 500 and 1 550 °C; corresponding plots of the 5-poise temperature are shown in Figure 5. Mineralogical analysis by T.Ya. Malysheva showed that the slags contain two main phases: anosovite and perovskite (Figure 6), the former being (Ref 10) a complex solid solution, $n[Fe, Al, Ti)_2O_3 \cdot TiO_2] \cdot n$[illegible]$e,Ti,Mg,Mn,Co,Ni)O.2TiO_2]$. Comparing their present and previous (Ref 1) work the authors conclude that the properties of slags are impaired by the lower oxides of titanium to a greater extent when lime is absent: a Ti_2O_3:TiO_2 ratio up to 1.5 is permissible with slags containing 5% CaO. They

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recommend the following range of composition: 39-89% TiO_2, 0-50% Ti_2O_3, 0-10% CaO with 4, 2, 5 and 2% of SiO_2, Al_2O_3, FeO and MgO, respectively.

There are 6 figures, 2 tables and 12 references, 9 of which are Soviet and 3 English.

SUBMITTED: March 5, 1960

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REZNICHENKO, V. A.

S/180/60/000/02/028/028
E071/E135

AUTHOR: Ogurtsov, S.V.

TITLE: Scientific Conference on the Metallurgy, Chemistry and Electrochemistry of Titanium

PERIODICAL: Izvestiya Akademii nauk SSSR, Otdeleniye tekhnicheskikh nauk, Metallurgiya i toplivo, 1960, Nr 2, pp 167-168 (USSR)

ABSTRACT: The conference took place on January 14-20 1960 in Moscow in the Institute of Metallurgy, Academy of Sciences, USSR. It was organised by the Committee for Coordination of Scientific Research on Titanium. About 400 representatives of academic and research institutions and works participated in the conference. The conference was divided into four sections: 1) raw materials and smelting of ores; 2) chemical technology and chlorination; 3) metallothermic methods of smelting titanium; and 4) electrolysis. The following papers were read:
Metallurgical evaluation of some new deposits (B.B. Dmitrovskiy); State and prospects of improving the technology of smelting of ilminite concentrates (V.A. Rezhnichenko and V.I. Solov'yev);

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Thermodynamic investigations of titanium compounds (F.B. Khalimov and V.A. Reznichenko); An investigation of the process of reduction of iron-titanium concentrates with carbon (M.B. Rapoport); Some hydrodynamic and kinetic features of the process of chlorination of titanium dioxide in molten chlorides (Kim Men-rin); Oxidation of titanium tetrachloride with oxygen (G.S. Moynov, B.N. Melent'yev, V.A. Rezhnichenko); Utilisation of ilminite concentrates for the production of titanium dioxide pigment by the sulphuric acid method (M.L. Borodina, S.B. Shaykevich, N.A. Gubarova); An investigation of some properties of the system $TiCl_4$ - $AlCl_3$ - $FeCl_3$ (N.K. Druzhinina); An Investigation of phase equilibria liquid-vapour in systems formed by titanium tetrachloride with chloroanhydrides of mono- and trichloroacidic acids (G.V. Seryakov, S.A. Vaks, L.S. Sidorina); Determination of the summary content of carbon in titanium tetrachloride (G.V. Seryakov, S.A.Vaks, I.M. Golovanov); Basic conditions for standardised

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Scientific Conference on the Metallurgy, Chemistry and Electrochemistry of Titanium

results of the process of production of titanium by the magnesium thermite method (S.V. Ogurtsov, V.A. Reznichenko, V.K. Ustinov, V.I. Kozhevnikov, A.I. Dedkov); On the two stage method of production of titanium by the sodium thermite method (V.A. Reznichenko, S.V. Ogurtsov); Production of a high purity titanium (V.I. Batashev); The influence of the content of chlorine in a high purity titanium sponge on the process of smelting and on the quality of the metal produced (G.M. Vaynshteyn); The production of titanium and its alloys by refining of black anodes (Academician I.P. Bardin, A.D. Khromov, V.I. Lukashin); On the theory of refining of titanium (V.A. Sukhodskiy); Production of titanium by electrolysis of titanium dioxide in fluoride-chloride melts (I.P. Bardin, A.A. Kazayn); Electrolytic production of titanium from chloride-fluoride melts (V.M. Ioffe, N.N. Rozanov, N.A. Lyubimova); Electrolytic refining of titanium waste products (V.M. Lozovatskiy); and a number of other reports.

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There are no figures, tables or references.

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S/598/60/000/004/001/020
D215/D302

15 2230

AUTHORS: Khalimov, F.B. and Reznichenko, V.A.

TITLE: Investigating the reduction processes of titanium dioxide and magnesium titanates

SOURCE: Akademiya nauk SSSR. Institut metallurgii. Titan i yego splavy, no. 4, Moscow, 1960. Metallurgiya titana, 14-20

TEXT: The aim of the authors was to discover the influence of MgO on the hydrogen reduction of TiO_2 in titanate slags by studying (a) phase transformations and (b) reaction kinetics. The reduction was carried out in H_2/H_2O mixtures and was followed gravimetrically to constant weight. Mixtures of chemically pure TiO_2 and MgO were briquetted, sintered in vacuum at 1500°C for 6 hours, and analyzed by X-ray crystallography. Initial mixtures contained between 5 and 42% MgO by weight; on sintering, this became incorporated into one or a mixture of two of $MgO,2TiO_2$, $MgO.TiO_2$ and $2MgO,TiO_2$. Any residue was TiO_2. The

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Investigating the reduction ...

wettest hydrogen (p_{H_2O}/p_{H_2} maximum) was used for the first reduction (at 1200°C) to constant weight; the ratio was then decreased and the reduction continued to a fresh constant weight, permitting the percentage reduction to be plotted against log $(\frac{p_{H_2O}}{p_{H_2}})$. The degree of reduction was substantially independent of hydrogen humidity and was 80 and 62% respectively. With the 15:85 mixture the 72:25 dititanate: TiO_2 material gave on reduction a solid solution of anosovite and some magnesium metatitanate of overall composition 16:47.37 $MgO:TiO_2:Ti_2O_3$. The degree of reduction increased with decreasing hydrogen humidity and reached a maximum of 80%. The 25:75 mixture (65:35 dititanate: metatitanate on sintering) gave a product 27:16:57 $MgO:TiO_2:Ti_2O_3$ in which crystal structures of $n(MgO.2TiO_2).m\ Ti_3O_5$ and orthotitanate were

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Investigating the reduction ...

identified. The 42:58 mixture (49:51 metatitanate: orthotitanate on sintering) showed at first a good response to decreasing the hydrogen humidity but further reduction had little effect and the degree of reduction was only 65%, resulting in 44:16:40 $MgO:Ti_2O_3$. With pure H_2 the results are given graphically. The 5:95 and 10:90 mixtures gave products containing both di- and metatitanate phases (probably solid solutions) while the 15% mixture gave only metatitanate, probably containing Ti_2O_3 in solution. The 25:75 mixture gave meta- and orthotitanates, and the 42:58 mixture orthotitanate only. Reduction in H_2O/H_2 atmospheres was also applied to mechanical mixtures of MgO and TiO_2 (up to 20% MgO), briquetted but not sintered. As MgO increased, less TiO_2 became reduced and more became combined as dititanate and, later, metatitanate. At sufficiently high temperatures the mechanical mixtures were reduced analogously to the titanates. It is believed that MgO stabilizes the hightemperature form of Ti_3O_5 as anosovite. There are 3 figures, 3 tables and 6 references: 3 Soviet-bloc and 3 non-Soviet-bloc. The references to the English-language publications read as follows:

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Investigating the reduction ...

I.H. Moore and H. Gigurdson, J. met., no. 12, (1949; K.A. Goklen and J. Shipman, J. met., no. 2,(1952); L.W. Coughanour, J. res. Nat. bur. min., 51, no. 2, (1953).

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15 2230

32109
S/598/60/000/004/002/020
D215/D302

AUTHORS: Khalimov, F.B. and Reznichenko, V.A.

TITLE: Investigating a new titanium oxide Ti_5O_9

SOURCE: Akademiya nauk SSSR. Institut metallurgii. Titan i yego splavy, No. 4. Moscow, 1960. Metallurgiya titana, 21-23

TEXT: In the course of an earlier investigation reported by the authors, some experiments in hydrogen reduction of TiO_2 to Ti_3O_5 were discontinued at an intermediate stage, and the briquettes then showed an inner dark blue and an outer dark brown layer. While the dark brown layer consisted mainly of Ti_3O_5, it was considered that the dark blue substance was higher oxide, but not TiO_2. It had been previously discovered by N.E. Filonenko et al.(Ref. 2: Dokl. AN SSSR, 86, no. 3, 1952), who gave it the formula $Ti_2O_3 \cdot 3\text{-}4TiO_2$. Chemical analysis indicated a compound in the range $TiO_{1.82}$-$TiO_{1.70}$ which on the basis of a

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general formula proposed by Scandinavian workers for lower titanium oxides of Ti_nO_{2n-1} could have been Ti_5O_9 or Ti_4O_7. On the reduction kinetics curves a bend was found at 60-70% reduction (of TiO_2 to Ti_3O_5) which approximately corresponded to Ti_5O_9 and which the authors adopted as the true formula. In the reaction $5TiO_2 + H_2 \rightleftharpoons Ti_5O_9 + H_2O$, values of $Kp = \frac{\% H_2O}{\% H_2}$ determined experimentally varied between 1.01×10^{-2} at 1293°K and $2.14\ 10^{-2}$ at 1473°K. Using Eq. (2)

$\Delta H_T = 4.576 T_1 \cdot T_2 \frac{\lg K_{P1} - \lg K_{P2}}{T_1 - T_2}$ the mean value of ΔH°_T

between 1300 and 1500°K was found to be 15.85 kcal/mole. The heat of formation of the oxide from its elements at 1400°K was calculated thermochemically to be -10.44 kcal/mole. The results are considered to

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supplement existing data on the lower titanium oxides invariably present in slags during the melting of titanium-containing materials. There are 1 figures, 1 table and 5 references: 4 Soviet-bloc and 1 non-Soviet-bloc. The reference to the English-language publication reads as follows: S. Andersson, B. Collen, U. Kuylenstierna and A. Magnelli, Acta Chem. Scand., 11, no. 10, (1957).

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AUTHORS: Reznichenko, V.A., Balikhin, V.C. and Karyazin, I.A.

TITLE: The influence of titanium dioxide on the electrical conductivity of slag

SOURCE: Akademiya nauk SSSR. Institut metallurgii. Titan i yego splavy. No. 4. Moscow, 1960. Metallurgiya titana, 24-27

TEXT: Since titanium dioxide and titanium tetrachloride were obtained by high-temperature electrolytic reduction of ilmenite concentrate melts, it is important to know the effect of slag constituents on electrical conductivity in order to avoid a dissipation of electrical energy instead of its conversion into heat. As a first step the influence of TiO_2 was selected for investigation. The method was based on measuring the out-of-balance current in a 4-arm bridge circuit with the furnace-enclosed electrolytic cell and a variable resistance constituting one arm and fixed resistances the other three. The bridge was initially

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The influence of titanium dioxide on the ...

balanced at a certain resistance value close to that expected, so that when unbalance arose current was fed across the bridge diagonal, proportionally to the deviation. This was recorded by a d.c. microammeter of the M 95 (M95) type, included in the diagonal together with a rectifier. Calibration was effected by using standard resistances in place of the cell; the limits of accuracy were 0.0001 ohm. Current supply was from a.c. mains at normal frequency. The measuring cell consisted on a eccentrically bored molybdenum crucible of 24 mm internal diameter forming one electrode, and a 3 mm diameter rod electrode which was immersed in the slag to a depth of 10 mm. The cell constant was determined using a standard 0.1N KCl solution, the circuit resistance by shorting the electrodes. Synthetic slags based on TiO_2-SiO_2-Al_2O_3-FeO-MgO with Al_2O_3 and MgO constant at 2% each and FeO/SiO_2 = 0.6 were investigated. These were made from chemically pure oxides, carefully mixed and briquetted. The furnace was of the Tamman type and the atmosphere oxygen-free nitrogen. The results are shown graphically. The anomalously

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high conductivity of high-titanate slags in comparison with silicates and the weak temperature dependence and high conductivity even in the solid state suggested that titanium dioxide conferred both ionic and electronic conductivity. There are 2 figures and 1 table.

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REZNICHENKO, V.A. (Moskva); UKOLOVA, T.P. (Moskva)

Effect of the addition of lower titanium oxides on the reduction of ilmenite by carbon. Izv.AN SSSR.Otd.tekh.nauk.Met.i topl. no.4: 26-28 Jl-Ag '60. (MIRA 13:9)
(Ilmenite) (Titanium--Metallurgy)

LUKASHIN, V.I. (Moskva); REZNICHENKO, V.A. (Moskva); KHROMOV, A.D. (Moskva)

Investigations on the electrochemical separation of titanium alloys.
Izv.AN SSSR.Otd.tekh.nauk.Met.i topl. no.4:29-32 Jl-Ag '60.
(MIRA 13:9)

(Titanium alloys--Electrometallurgy)

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D215/D302

AUTHORS: Reznichenko, V.A. and Solomakha, V.P.

TITLE: Chlorination of titanium monoxide and dioxide

SOURCE: Akademiya nauk SSSR. Institu metallurgii. Titan i yego splavy. No. 4. Moscow. 1960. Metallurgiya titana, 39-53

TEXT: An investigation of the kinetics and thermodynamics of the chlorination of TiO and TiO_2 with molecular Cl_2 is described, after a theoretical discussion based on Soviet-bloc and Western work. Knowledge of these reactions is said to be of great practical value in treating Ti-containing slags. The chlorinations were studied by passing dry Cl_2 (in 50.% excess) at 6 l/hr over 10g compacts of the solid reactants, in a tubular furnace, for 1 1/2 hours. The compacted reactants consisted of Ti oxide (100), petroleum coke (50) and coal tar pitch in CCl_4 (8 parts) and were first briquetted, dried and degassed in vacuum

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Chlorination of titanium ...

at 800°C. The reaction tube was purged with N_2 before and after each experiment and all products were collected and analyzed, following the extent of the reactions by measuring the yields of $TiCl_4$. Oxygen contents in the gaseous and solid products and the initial and final TiO_2 contents were also determined. The above 3 methods gave closely similar results. An empirical relationship $B^2 = -b + kQ$, where B=% chlorination, Q-gas flow and b and k are constants, was discovered for TiO_2, for Q varying between 2 and 13 l/hr, at 700°C. At 6l of Cl_2 per hour, up to 60% excess of C over the stoichiometric amount had no effect on B. The relationships between B and time, at 400°C, 500°C, 600°C, 700°C and 900°C are shown graphically. It was found that the extent of chlorination could be expressed as $B^2 = -b + A \cdot t \cdot e^{\frac{-E}{RT}}$, where t = time, A, R and T have the usual meanings and the activation energy E was ~1,650 cal/mole for the initial straight portion of the curves and increased

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to 2,200 cal/mole for the parabolic parts of the curves. TiO was chlorinated at lower temperatures and little advantage was obtained by working above 600°C. There are 8 figures, 2 tables and 13 references: 11 Soviet-bloc and 2 non-Soviet-bloc. The reference to the English-language publication reads as follows: G. Skinner, H.L. Johnston and C. Beckett; 'Titanium and its compounds' Columbus, Ohio, 1954.

S/598/60/000/004/008/020
D217/D302

AUTHORS: Karyazin, I.A. and Reznichenko, V.A.

TITLE: Studying the influence of the lower oxides of titanium on the viscosity and fluidity of titanium slags

SOURCE: Akademiya nauk SSSR. Institut metallurgii. Titan i yego splavy. No. 4. Moscow, 1960. Metallurgiya titana, 73-88

TEXT: The slag system studied corresponded in their composition to the natural Ti slags produced in smelting Irshinsk ilmenite concentrates. Synthetic slags of the composition shown in Table 1 were used.

Table 1. Composition of synthetic titanium slags

Components	Content, % System No. 1	System No. 2	System No. 3
TiO_2	22-92	18-88	19-89
Ti_2O_3	0-70	0-70	0-70
FeO	0-20	0-20	3
CaO	0	0	0-20
SiO_2	4	4	4
Al_2O_3	2	2	2
MgO	2	6	2

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On the basis of results obtained from the study of the viscosity of these slag systems, viscosity and fluidity diagrams were plotted analagously to the Mac-Caffery diagrams. The materials used for preparing synthetic slags were pure TiO_2, SiO_2, Al_2O_3, CaO, MgO, FeC_2O_4 and titanium sesquioxide. 40-gram batches were used for each experiment, after thorough mixing and briquetting. The slag viscosity was measured by a rotary electroviscometer. The slags were melted in crucibles made from sintered molybdenum powder, in an atmosphere of oxygen-free nitrogen. A W-Mo thermocouple was used for the temperature control of the molten slag. Since a reaction occurs in the molten slag between titanium sesquioxide and ferrous oxide, resulting in the formation of TiO_2 and metallic Fe, the slag was analyzed chemically after the experiment for its titanium sesquioxide or metallic Fe content. The slag composition was converted to the actual ratio between the components. All the slags investigated were also subjected to mineralogical study. The temperature, at which the slags had a viscosity of 5 poise was taken as the fluidity temperature of the slags. It was found that the lower titanium oxide (Ti_2O_3) causes an increase in viscosity and fusibility of titanium

Studying the influence ...

slags, the ratio Ti_2O_3:TiO_2 being an important characteristic of titanium slags. In systems nos. 1 and 2, ferrous oxide exerts a considerable influence on the reduction in viscosity and fusibility of slags, this influence being less pronounced in a system containing 6% MgO than that containing 2% MgO. The following limiting composition ranges represent the optimum with respect to the properties of fusibility and fluidity of the systems investigated. System no. 1: 47-82% TiO_2, 0-45% Ti_2O_3, 0-5% FeO at an SiO_2 content of 4%, 2% Al_2O_3 and 2% MgO. System no. 2: 58-88% TiO_2, 0-30% TiO_2, 0-5% FeO at a SiO_2 content of 4%, 2% Al_2O_3 and 6% MgO. System no. 3: 34-89% TiO_2, 0-50% TiO_3, 0-10% CaO at an SiO_2 content of 4%, 2% Al_2O_3, 3% FeO and 2% MgO. The most fluid titanium slags are produced on using CaO as flux, the best result being obtained at 5% CaO. The undesirable influence of Ti_2O_3 on the physical properties of Ti slags are particularly pronounced in systems free from CaO,

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especially if the MgO content is high. Electrolytic melting of concentrates can be most economic and the output highest when CaO is used as the flux. However, since in the chlorination of slags of such composition the $CaCl_2$ of high melting point is formed, the addition of flux to the burden should be such that the CaO content of the slag does not exceed 10%. There are 11 figures, 5 tables and 3 references: 2 Soviet-bloc and 1 non-Soviet-bloc. The reference to the English-language publication reads as follows: R.C. Mac-Caffery. Trans. Am. Inst. Min. and Met. Eng., v. 190, 1932.

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S/598/60/000/004/009/020
D217/D302

AUTHORS: Reznichenko, V.A. and Khromova, N.V.

TITLE: Studying the solubility of the lower oxides of titanium in sulphuric acid

SOURCE: Akademiya nauk SSSR. Institut metallurgii. Titan i yego splavy. No. 4. Moscow, 1960. Metallurgiya titana, 89-94

TEXT: The solubility of Ti_3O_5, Ti_2O_3 and TiO in H_2SO_4 was investigated. The experiments were carried out with 1 : 1 H_2SO_4 at 70, 80, 90, 100 and 110°C for 6-8 hours. The volume ratio between solid and liquid was 1 : 100. The experiment was carried out as follows: 0.5 grams of the substance under investigation and 50 ml H_2SO_4 were placed in a 50 ml flask provided with a glass stirrer. The temperature was maintained constant within ± 2°C. In order to determine the solubility with time, 2 ml samples were taken each hour. These were analyzed for Ti content

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by a photocolorimetric method. The decomposition of the slag in H_2SO_4 is determined mainly by the mineral composition of the slag. The main mineral of Ti slags is anosovite, which is an isomorphic series of three Ti_3O_5-base solid solutions. Pure anosovite, without isomorphic impurities, is a high-temperature modification of Ti_3O_5 which can be obtained in the presence of modifiers (Al_2O_3 or MgO). The authors investigated the solubility of Ti_3O_5 as produced by the method developed at Institut metallurgii, AN SSSR (Institute of Metallurgy, AS USSR). Ti_2O_3 also prepared by a method developed at this Institute, was studied with respect to its reaction with H_2SO_4. By means of straight-line curves, expressing the temperature dependence of the solution rate of titanium oxides, the apparent energies of activation for the dissolution of these oxides in H_2SO_4 were calculated. The results of these calculations are:

$E_{Ti_3O_5}$ = 18 kcal/mol; $E_{Ti_2O_3}$ = 21 kcal/mol and E_{TiO} = 15 kcal/mol. It was found that TiO exhibits the greatest solubility, Ti_2O_3 the least, and Ti_3O_5 is intermediate between the two. There are 6 figures, 4 tables and 1 non-Soviet-bloc reference.

S/598/60/000/004/013/020
D217/D302

AUTHORS: Reznichenko, V.A., Ogurtsov, S.V. Lopatin, G.S. and Melikbekova, S.A.

TITLE: Study of titanium production by the thermal magnesium method

SOURCE: Akademiya nauk SSSR. Institut metallurgii. Titan i yego splavy. No. 4. Moscow, 1960. Metallurgiya titana, 122-131

TEXT: The purpose of this work was to study the nature of processes occurring during reduction of $TiCl_4$ both under laboratory and close to production conditions. First of all, the distribution of the products of reaction was studied. The work was carried out in a laboratory reactor in the following sequence: 150-160 g of etched Mg was charged into the reaction vessel, the pressure reduced to 1.10^{-3} mm Hg and purified argon passed to a residual pressure of 20-30 mm Hg. This procedure was repeated 3-4 times. Definite portions of $TiCl_4$ were transferred to the reactor at 750°C. After each transfer, the process was

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Study of titanium ...

interrupted and the reactor cooled to room temperature in an argon atmosphere. The reacting mass was cut longitudinally into two portions. One portion was used for photography and from the other, samples of the products of reaction were taken from various points and analyzed for Mg, Cl_2, Ti, and in an aqueous extract, for Mg and Cl_2. To study the distribution of metallic Ti, particularly with small tetrachloride consumptions (2-15%), the method of taking color prints in chromotropic acid was used. The results obtained in laboratory investigations were verified under production conditions. It was found that the production of metallic Ti by the thermal Mg method is a complicated physico-chemical process. The distribution of the products of reaction during the process and the formation and growth of Ti sponge are the same under laboratory as under production conditions. The formation of the profile of the growing Ti sponge can be controlled by varying the rate of supply of $TiCl_4$.

Soaking the products of reaction after the end of the process had no effect on the grain size of Ti. The conglomeration of Ti particles into sponge is due to their adhesion to Mg. There exists a relationship

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between specific pressure and the rate of $TiCl_4$ supply which may be viewed as the reaction characteristic of the reduction process. By applying this reaction characteristic, it is possible to select the optimum rates of $TiCl_4$ supply to ensure maximum efficiency and a high recovery of Mg. Application of cooling enables $TiCl_4$ to be supplied at high average rates at any given temperature. There are 4 figures.

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S/598/60/000/004/014/020
D217/D302

AUTHORS: Ogurtsov, S.V. and Reznichenko, V.A.

TITLE: Study of the kinetic characteristics of processes occurring during the reduction of titanium tetrachloride by magnesium

SOURCE: Akademiya nauk SSSR. Institut metallurgii. Titan i yego splavy. No. 4, Moscow, 1960. Metallurgiya titana, 132-139

TEXT: The kinetics of $TiCl_4$ reduction by Mg in the initial period of reaction, using 20, 40 and 60% $TiCl_4$ were investigated. The study was carried out in a laboratory reactor; an apparatus was constructed by V. Kozhevnikov, in which the temperature and pressure could be simultaneously recorded on one strip diagram. The apparatus consisted of two parts, an electron potentiometer for temperature recording and a balanced alternating current bridge. The pressure transmitting element was made in the form of a U-shaped mercury manometer. The temperature was measured by means of a chromel-alumel thermocouple which, in order

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S/598/60/000/004/014/020
D217/D302

Study of the kinetic...

to ensure greater accuracy, was pushed against the wall inside the reaction vessel at the level of molten Mg. In order to study the influence of temperature on the rate of reaction, the processes were commenced at various temperatures (700, 750, 800, 850 and 900°C). To elucidate the influence of the rate of supply of $TiCl_4$ on the rate of reaction, the liquid was supplied in portions of 2, 5, 10 and 15 cm^3. For studying the kinetics of reactions occurring during and at the end of the thermal Mg process, the same method was used as that for studying the initial period of the process. It was found that the mechanism of reduction of $TiCl_4$ by Mg is autocatalytic. In the middle of the process, the surplus of the sponge, being the catalyst, receives a considerable boost and the apparent energy of activation of the process is still further depressed. The rate of the process depends on temperature, rate of supply of $TiCl_4$ and development of the sponge surface. As the rate of supply of tetrachloride is increased, so the catalyst surface and the yield of Mg in the reaction zone increase, as a result of which the rate of the process increases. The gaseous residues of the evaporating tetrachloride

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(5 4.0 of the liquid supplied) react only very slowly and their role in the process is insignificant. By varying the rate of supply or the proportion of $TiCl_4$ supplied, the process can be controlled with respect to both sponge formation and rate of reaction. There are 6 figures.

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S/137/62/000/002/003/1[illegible]
A006/A101

AUTHORS: Balikhin, V. S., Reznichenko, V. A.

TITLE: Electric conductivity of melts of the ferrous oxide-titanium dioxide system

PERIODICAL: Referativnyy zhurnal, Metallurgiya, no. 2, 1962, 11-12, abstract 2A55 ("Izv. AN SSSR, Otd. tekhn. n.", 1961, no. 4, 24-28)

TEXT: Electric conductivity of slags was measured by the method of a non-equilibrium bridge at up to 1,900°C. The samples were prepared by mixing and briquetting of chemically pure components. After completed experiments samples were pumped-off for mineralogical and X-ray analyses. It was established that Ti-oxides have high (for oxides) electronic conductivity. Bends corresponding to ferrous ortho- and metatitanate, were observed on isotherms showing changes in the electric conductivity of slags in the $FeO-TiO_2$ system. The high electronic conductivity of Ti-dioxide under weakly reducing conditions is apparently caused by the appearance of defects in the rutile lattice on account of the partial oxygen loss. The high electronic conductivity of the slags investigated in the $FeO-TiO_2-Ti_2O_3$ system, leads to the assumption that the solid solutions

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on Ti_3O_5 and Ti_2O_3 lattice base (anosovite and tagirovite) possess also high conductivity. These minerals are the basic phases of industrial titanium slags and assure their high conductivity.

T. Kolesnikova

[Abstracter's note: Complete translation]

APPROVED FOR RELEASE: 03/14/2001 CIA-RDP86-00513R001444810007-2"

S/137/62/000/006/045/163
A006/A101

AUTHORS: Dmitrovskiy, Ye. B., Reznichenko, V. A., Solomakha, V. P.

TITLE: Developing a system of using leucoxene-containing ores

PERIODICAL: Referativnyy zhurnal, Metallurgiya, no. 6, 1962, 15, abstract 6G112 (In collection: "Titan i yego splavy", no. 5, Moscow, AN SSSR, 1961, 13-16)

TEXT: An electromagnetic concentration scheme with preliminary reduction-roasting of ore was selected for the concentration of Ti-ore, represented by leucoxene-enriched sandstone. Prior to roasting the ore is mixed with petroleum coke, the roasting temperature is 1,150°C and duration 1.5 hours. Electromagnetic separation is conducted in a field of about 2.000 oersted strength. The concentrate obtained contains 42 - 43% TiO_2, 14.4% Fe_2O_3 and is chlorinated at 900°C. The percentage of chlorination is 98.9 for Ti, 8.3 for Si, 94.5 for Al, % for Fe. Cl consumption per 1 ton of concentrate is 1.23 tons.

L. Vorob'yeva

[Abstracter's note: Complete translation]

Card 1/1

DMITROVSKIY, Ye.B.; REZNICHENKO, V.A.; Prinimali uchastiye: RUDNEVA, A.V.; MALYSHEVA, T.Ya.

Metallurgical estimate of macrocrystalline titanium-magnetite ores. Titan i ego splavy no.5:20-27 '61. (MIRA 15:2)
(Titanium--Metallurgy)
(Magnetite--Metallurgy)

S/137/62/000/006/026/163
A006/A101

AUTHORS: Dmitrovskiy, Ye. B., Reznichenko, V.A.

TITLE: Metallurgical evaluation of ilmenite-titanium-magnetite ores

PERIODICAL: Referativnyy zhurnal, Metallurgiya, no. 6, 1962, 13, abstract 6G92 (In collection: "Titan i yego splavy", no. 5, Moscow, AN SSSR, 1961, 28 - 33)

TEXT: The basic ore minerals of the deposit investigated are titanium magnetite and ilmenite; they are sufficiently isolated which is a favorable circumstance for ore concentration by the following scheme: a) electromagnetic separation on a wet-drum separator with subsequent refining of the magnetic and non-magnetic fractions obtained; b) concentration on a table of the non-magnetic portion and separation of the ilmenite concentrate; c) refining of the ilmenite concentrate on a dry electromagnetic separator. The yield of the titanium-magnetic concentrate is 79.8% and that of ilmenite concentrate is 4.6%. TiO_2 and total Fe content in the titanium magnetite concentrate are 13.05 and 50.67% respectively; and 38.95 and 34.7% in the ilmenite concentrate. The slags ob-

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Metallurgical evaluation of...

tained as a result of concentrate melting, contain 44.5% TiO_2, (titanium-magnetite slag) and 70% TiO_2 (ilmenite slag). The TiO_2 content in the titanium-magnetite slag can be raised to 76 - 78% by processing with HCl.

L. Vorob'yeva

[Abstracter's note: Complete translation]

Card 2/2

MURAVCVSKIY, S.A., mashinist-instruktor; [illegible], V.A., mashinist-elektrovoza; MAKSIMOV, V.A., inzh.

Engineers on the a.c. powered N60 electric locomotives should know this. Elek. i tepl. tiaga 5 no.5:39-40 My '61.
(MIRA 14:7)

(Electric locomotives)
(Electric railroads--Employees)

MURAKHOVSKIY, B.A., mashinist-instruktor (g.Krasnoyarsk); REZNICHENKO, V.A., mashinist elektrovoza (g.Krasnoyarsk); MAKSIMOV, A.A., inzh. (g.Krasnoyarsk)

What the operator of a N60 a.c.electric locomotive should know. Elekt.i tepl. tiaga 5 no.10:32-34 O '61. (MIRA 14:10)

1. Chleny initsiativnoy gruppy vneshtatnykh korrespondentov zhurnala "Elektricheskaya i teplovoznaya tyaga".
(Electric locomotives)

MURAKHOVSKIY, B.A., mashinist-instruktor; REZNICHENKO, V.A., mashinist elektrovoza; MAKSIMOV, A.A., inzh.

Engineers of the a.c. powered N60 electric locomotives should know this. Elek. i tepl. tiaga 5 no.6:36-37 Je '61. (MIRA 14:10)
(Electric locomotives) (Locomotive engineers)

REZNICHENKO, V.A.; SIDORENKO, G.D.

Results of testing on the sintering of titanium concentrates. Titan i ego splavy no.5:50-53 '61. (MIRA 15:2)
(Sintering)
(Titanium ores)

S/137/62/000/006/028/163
A006/A101

AUTHORS: Reznichenko, V. A., Sidorenko, G. D., Solov'yev, V. I., Karyazin, I. A., Dmitrovskiy, Ye. B., Afanas'yev, T. V.

TITLE: Developing electric melting techniques for perovskite-titanium-magnetite sinter

PERIODICAL: Referativnyy zhurnal, Metallurgiya, no. 6, 1962, 13, abstract 6G94 (In collection: "Titan i yego splavy", no. 5. Moscow, AN SSSR, 1961, 54 - 59)

TEXT: As a result of experimental industrial investigations on the electric melting of perovskite titanium-magnetite sinter, the possibility was proved of extracting Nb into cast-iron and of obtaining titanous slag. Nb cast-iron can be used as an initial product to obtain Nb slag which is a raw material for producing Nb metal. Titanous slag can be employed for TiO_2 production. For melting, sinter was used containing 25% perovskite and 75% titanium-magnetite concentrates. The Fe content in the sinter was 39 - 45%, TiO_2 content was 12 - 15%. Melting was conducted in an ore-heating furnace with a cupola. Its capacity is

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...veloping electric melting...

...500 kvamp; the electrodes are arranged in a triangle, the diameter of the electrode configuration is 1,500 mm. The heats yielded Nb-cast iron and titanous slag. The medium TiO_2 content of the total slag amount was 34% at 1.0% FeO content. The cast-iron obtained contained up to 0.1; 0.2 and 0.3% Nb. The degree of Nb extraction into the cast iron was then 31.5, 63.0 and 94.5%. The average electric power consumption per heat was 2,880 kw-h/ton. The operational voltage during the melting process was 100 - 150 v. Prior to teeming the slag the furnace was switched-off. The temperature at which the slag was removed from the furnace was 1,450 - 1,500°C.

G. Svodtseva

[Abstracter's note: Complete translation]

Card 2/2

REZNICHENKO, V.A.; TKACHENKO, V.A.; SIRYAPOV, G.V.; KOZLOV, V.M.; SIDORENKO, G.D.

Reduction of ilmenite concentrates in a fluidized bed. Titan i ego splavy no.5:60-64 '61. (MIRA 15:2)
(Titanium--Metallurgy)
(Fluidization)

S/137/62/000/006/032/163
A006/A101

AUTHORS: Reznichenko, V. A., Ukolova, T. P.

TITLE: Investigating interaction processes of lower titanium oxides with ilmenite

PERIODICAL: Referativnyy zhurnal, Metallurgiya, no. 6, 1962, 13, abstract 6G98 (In collection: "Titan i yego splavy", no. 5, Moscow, AN SSSR, 1961, 75 - 79)

TEXT: Experiments on the interaction of ilmenite with Ti_2O_3 were conducted under neutral conditions and in a vacuum. With an increasing ilmenite : Ti_2O_3 ratio, the completeness of interaction decreases, i.e. the higher the solubility of ilmenite in Ti_2O_3, the lower its activity. Activity of Ti^{3+} is particularly reduced with its decreasing concentration in the ilmenite. If the ilmenite : Ti_2O_3 ratio is 0.25 : 1, a solid solution of ilmenite in Ti_2O_3 is formed, named "tagirovite". At a higher ratio a solid solution of Ti_2O_3 in the ilmenite, the crichtonite, is formed. At a ratio > 0.5 : 1, a solid solution is formed being ferrous anosovite.
[Abstracter's note: Complete translation]

L. Vorob'yeva

Card 1/1

REZNICHENKO, V.A.; UKOLOVA, T.P.

Synthesis of anosovite and of solid solutions on the basis of a titanium sesquioxide lattice. Titan i ego splavy no.5:80-84 '61. (MIRA 15:2)

(Anosovite)
(Titanium oxide)

S/137/62/000/007/004/072
A052/A101

AUTHORS: Balikhin, V. S., Reznichenko, V. A.

TITLE: Electric conductivity of titanium slags

PERIODICAL: Referativnyy zhurnal, Metallurgiya, no. 7, 1962, 10, abstract 7A54 (In collection: "Titan i yego splavy". Moscow, AN SSSR, no. 5, 1961, 95 - 101)

TEXT: Electric conductivity $\varkappa$ of high-titanium slags (80 - 90% TiO_2) is reduced 2 - 3 times by adding limestone or dolomite to the charge with the purpose of obtaining slag with 4 - 6% CaO which creates conditions for a smoother electro-smelting process. A further increase of fluxing components in the slag, although it secures more favorable conditions for smelting concentrates, makes the slag considerably poorer in respect of TiO_2 and deteriorates its quality. The presence of FeO in slag has no considerable effect on its $\varkappa$. A further increase of FeO up to 15% causes a gradual decrease of $\varkappa$ owing to TiO_2 impoverishment of slag, which is a decisive factor affecting $\varkappa$ of slag. Contrary to notions that existed previously, it has been established that an increase of the degree of overreduc-

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Electric conductivity of titanium slags

tion of Ti_2O_3/TiO_2 slag from 0 to 0.8 changes its $\varkappa$ insignificantly. A decrease of the resistance of the smelt at the end of the electrosmelting and the change of the furnace to the arc process are connected obviously with a higher Ti concentration in slag and not with the emergence of lower Ti oxides. As an explanation of unusually high $\varkappa$ for slags, which TiO_2 imparts to them, the assumption can be made that at smelting in a reducing atmosphere TiO_2, like FeO and MnO, has an electronic conduction.

Authors' summary

[Abstracter's note: Complete translation]

S/598/62/000/005/001/010
D040/D113

AUTHORS: Remnichenko, V.A., and Solomakha, V.P.

TITLE: An investigation of the titanium slag chlorination process

SOURCE: Akademiya nauk SSSR. Institut metallurgii. Titan i yego splavy, no. 5, Moscow, 1961. Metallurgiya i khimiya titana, 108-114

TEXT: The investigation was conducted with slags obtained by reduction melting of ilmenite concentrate, which is a less costly method of obtaining titanium tetrachloride than direct chlorination of ilmenite concentrate, which requires high quantities of chlorine gas and produces iron chlorides which cannot be utilized in industry. Chlorination of pure titanium oxides TiO_2, Ti_3O_5, Ti_2O_3 and TiO, and titanium carbide had been tried previously and the described experiments are a continuation of studies in this field. The study was conducted to investigate the effect of the chemical and mineralogical composition of slags on the intensity of chlorination; the

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features of processes using different slag types; the effect of low Ti oxides, of calcium, magnesium and iron oxide, silica, alumina and carbon; variations in the gaseous phase composition during the chlorination process. The experimental unit consisted of pipings for chlorine gas and inert gas leading from chlorine and nitrogen containers, three columns with calcium chloride for gas drying, and a vertical celite furnace with a quartz reaction tube holding cakes of slag through which chlorine gas penetrated from the bottom and upwards. The article includes details of techniques and the chemical composition of eleven slag types used. Conclusions: (1) Low titanium oxides slow down the process of titanium slag chlorination and raise the carbon monoxide content in the gaseous phase; (2) Calcium oxide (5.3%) and magnesium oxide (6.8%) speed up the chlorination of titanium slags. Therefore, titanium slags obtained by flux melt are chlorinated faster than chemically pure titanium dioxide and considerably faster than slags from ilmenite concentrate melts without addition of a flux. The activating effect of magnesium and calcium oxides on the chlorination process of titanium slags confirms that the process is of an absorption-chemical type. There are 4 figures and 8 tables.

BK

S/598/61/000/005/002/010
D040/D113

AUTHORS: Remichenko, V.A., and Solomakha, V.P.

TITLE: Investigation of the titanium dioxide chlorination process

SOURCE: Akademiya nauk SSSR. Institut metallurgii. Titan i yego splavy, no. 5, Moscow, 1961. Metallurgiya i khimiya titana, 115-119

TEXT: Experiments were conducted (1) to study the effect of chlorine gas flow velocity in chlorination of TiO_2 in the presence of solid carbon, the degree of chlorine utilization, and the composition of the forming gas, and (2) to find means of accelerating the existing process and developing new chlorination processes for titanium ores. Temperature variations tried in previous experiments had an insufficient effect. The subject experiments were conducted with TiO_2 coke charges of 10 g weight in a reaction tube, at chlorine gas consumption between 0.35 and 26 l/hr and flow velocity between 20 and 120 cm/min. The investigation details were described previously by the authors (Symposium "Titan i yego splavy" ["Titanium and Its Alloys"],

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Investigation of the titanium dioxide ...

yye. 4, Ind-va (Ural SSSR). Chlorination was carried out at 700°C, and the gas composition variations studied at 700°, 800° and 900°C. Increase of gas flow velocity greatly speeded up the process, e.g. from 60 min at 6 l/hr chlorine consumption and 33.3 cm/min velocity to 35 min at 18.25 l/hr and 120 cm/min. A velocity increase over 120 cm/min had practically no effect on the chlorination intensity or the $TiCl_4$ output per 1 cm^2 of the cross section area of the reaction tube. The relative quantity of CO in the forming gas increased with increase in temperature and chlorine flow velocity. Chlorine breakthrough occurred every time at $TiCl_4$ output of 69-73%, regardless of the permeability of charge in the tube and of the chlorine flow velocity. This led to the assumption that the process can be intensified by high chlorine consumption, and that the use of a boiling layer will be the proper norms for chlorination of TiO_2. Conclusions: (1) Hydrodynamic factors have a predominant effect in the process, and chlorine blowback is caused only by the diffusion resistance of the medium due to excess of releasing agent, density of cakes, etc. Chlorine blowback can always be pre-

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vented in industrial shaft furnaces. (2) The chlorination process of TiO_2 appears to be of a sorptional nature, i.e. its place is mainly in the sorption layer formed by molecules of Cl, CO and CO_2 on the surface of TiO_2 and carbon which are in close contact in the cakes. Intermediate compounds may form in this layer and act as chlorination agents. There are 2 figures and 2 tables.

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S/137/62/000/006/042/163
A006/A101

AUTHORS: Moynov, S.G.; Melent'yev, B.N.; Reznichenko, V.A.

TITLE: Oxidizing titanium tetrachloride with oxygen

PERIODICAL: Referativnyy zhurnal, Metallurgiya, no. 6, 1962, 15, abstract 6G108 (In collection: "Titan i yego splavy", no. 5, Moscow, AN SSSR, 1961, 205 - 210)

TEXT: The process of $TiCl_4$ oxidation begins at 700°C, and at 1100 - 1150°C practically full burning-out of $TiCl_4$, supplied to the reaction zone, takes place. The process of $TiCl_4$ oxidation consists of the following two stages: 1) oxidation reaction in the gaseous phase, 2) oxidation on the solid and gaseous interface. Dispersity of TiO_2 obtained depends upon the temperature of $TiCl_4$ oxidation. It increases with higher temperature, attaining a maximum value at 1150°C (92.5%). The TiO_2 produced was a mixture of rutile and anatase TiO_2 modifications and had adsorbed a certain amount of Cl.

L. Vorob'yeva

[Abstracter's note: Complete translation]

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S/137/62/000/006/029/163
A006/A101

AUTHORS: Trkov, F. Ya., Reznichenko, V. A., Solov'yev, V. I., Solomakha, V.P.

TITLE: Utilization of slags from titanium-magnetite melting for the production of titanium dioxide and titanium tetrachloride

PERIODICAL: Referativnyy zhurnal, Metallurgiya, no. 6, 1962, 13, abstract 6G95 (In collection: "Titan i yego splavy", no. 5, Moscow, AN SSSR, 1961, 279 - 281)

TEXT: Slags from titanium-magnetite melting are easily decomposed by 95 - 96% H_2SO_4 at 160 - 210°C within 3 hours. TiO_2 extraction is then $\geqslant$ 90%. The H_2SO_4-slag ratio varied from 1.2 to 2.8 (optimum ratio 1.4 - 1.5). To raise the TiO_2 content in the slags, they were additionally enriched with 24% HCl. Then a Ti-concentrate with 68 - 69% TiO_2 was obtained. The Ti concentrate can be chlorinated and $TiCl_4$ obtained.

G. Svodtseva

[Acstracter's note: Complete translation]

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S/598/61/000/006/001/034
D245/D30[illegible]

AUTHORS: Ogurtso[illegible] S.V., Reznichenko, V.A., Ustinov, V.K., Kozhevnikov, V.N., and Dedkov, A.I.

TITLE: Basic conditions for the magnesiothermal process of producing titanium

SOURCE: Akademiya nauk SSSR. Institut metallurgii. Titan i yego splavy. no. 6, 1961. Metallotermiya i elektrokhimiya t[illegible]tana, 3 - 13

TEXT: A series of experiments was carried out in a laboratory reactor to study the distribution of reaction components in the formation and growth of Ti sponge and the factors governing the reaction of $TiCl_4$ with Mg. In all experiments, the following were recorded: Furnace temperature before insertion of retorts, furnace heating rate, Ar temperature and pressure in the retort at the beginning of the process, amount of $MgCl_2$ formed and pressure over the tanks containing $TiCl_4$. The Mg was completely fused prior to the process. An exponential relation was found between the feed

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Basic conditions for the ...

rate of $TiCl_4$ and specific pressure. Detailed results are shown in diagrams. The authors conclude that automation of the process can best be effected by optimum programming of $TiCl_4$ feed. There are 4 figures.

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S/598/61/000/006/007/034
D228/D303

AUTHORS: Ogurtsov, S.V., Revyakin, A.V., and Reznichenko, V.A.

TITLE: Study of the physico-chemical bases of the reduction of $TiCl_4$ by sodium

SOURCE: Akademiya nauk SSSR. Institut metallurgii. Titan i yego splavy. no. 6, 1961. Metallotermiya i elektrokhimiya titana, 41 - 49

TEXT: Despite the industrial use of the sodiothermic process for producing metallic Ti, no data have been published on the theoretical aspects of the reduction of $TiCl_4$ by Na, so the authors studied this question in particular: 1) The distribution of reaction products at different temperatures; 2) The role of mixing; 3) The influence of both the consumption of $TiCl_4$ on the yield of sponge and soaking the reaction products on the grain coarsening; and 4) The reaction mechanism. The experiments were conducted with purified Na in an argon-filled beaker fitted with a rotatable mixer. Temperature influence. The results of various tests show that no reduction

Card 1/3

Study of the physico-chemical ...

occurs at <[illegible]0° under isothermic conditions; in exothermic reactions the process starts at 500 - 550°, however, mixing of the reaction products lowers the critical temperature to 320° and 270° respectively. Distribution of reaction products. Na is coated with a crust of Ti and chlorides at 550°, which impedes the continuance of the reaction. At 650°, after 30 % of the $TiCl_4$, has been consumed, reaction products with a Ti content of 12 - 13 % grow above the original level of the molten Na in which cavities appear, being coated with a pyrophoric layer of chlorides; some $TiCl_3$ is formed on the surface of the sponge when [illegible]0 % of the $TiCl_4$ has been reduced. Above 800° the sponge grows up the beaker's sides, the respective Ti content of the reaction products and sponge after 30 - 70 % of the $TiCl_4$ has been consumed being 21 - 29 % and 13 - 20 %. Influence of $TiCl_4$ consumption on the yield of sponge. More of the reducer is used up in the sodiothermic process than in the case in the magnesiothermic process. The optimum consumption of $TiCl_4$ is 97 - 100 % of its stoichiometric quantity for the reduction process; the consumption of Na per 1 g of sponge is also at a minimum in this event. Particle coarsening. The increase of the reaction tem-

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Study of the physico-chemical ...

perature considerably raises the yield of coarse Ti: in high temperature processes the content of the >12-mesh fraction is 60 % as compared with 20 - 30 % at lower temperatures. Soaking for 3 hours at 900° also boosts the yield of coarse Ti. Na is believed to enter the reaction zone as a result of evaporation, and the reaction proceeds on the growing sponge's surface and in its upper part between the $TiCl_4$ and Na. Only mixing removes the crust on the Na below 650°, but at this temperature the vapor-tension of Na is sufficient for it to penetrate the reaction mass; reduction occurs gradually with the formation of titanous chlorides as intermediate products. Above 800°, when the sponge is coated with molten NaCl, the vapor-tension of Na is much higher, so no transitional layer of lower chlorides is present. In conclusion the authors note the similarity of many of the features of the reduction of $TiCl_4$ by Na and Mg at elevated temperatures, though the latter results from the capillary rise of the liquid. A further difference may be that in the sodiothermic process Ti conglomerates into a sponge through the sintering of discrete grains -- hence the yield of the coarse fractions is greater at high temperatures. There are 7 figures.

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S/598/61/000/006/008/034
D228/D303

AUTHORS: Ogurtsov, S.V., Reznichenko, V.A., and Yegorov, S.I.

TITLE: Investigating the sodiothermic method of titanium preparation

SOURCE: Akademiya nauk SSSR. Institut metallurgii. Titan i yego splavy. no. 6, 1961. Metallotermiya i elektrokhimiya titana, 50 - 59

TEXT: In this work the authors' aim was to secure information on certain insufficiently-studied aspects of the sodiothermic method of $TiCl_4$ reduction: The effect of subsequent additions of the reducer on the distribution of the reaction products; the character of the temperature distribution with respect to the reactor's height; and the influence of thermal conditions on the sponge's fractional composition. Their apparatus consisted of a distillation crucible, a feeder with a stop-rod and leveler, and a reactor. The temperature was maintained at 650 - 750° or above 800° during the experiments. Three thermocouples were fitted to the side of the beaker,

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their positions corresponding to the original level of the liquid Na, the final level of the reaction products, and the level of the gaseous phase. Tests on the distribution of the reaction products in the interval 650 - 750° disclosed that the addition of liquid Na in the first and second periods of the reaction decreases the size of the void at the bottom of the beaker, which thus permits the more efficient use of the reactor's full volume; moreover the reaction volume increases as the amount of the original sodium charge decreases, since the sponge starts to grow above the level of the molten reducer. Above 800°, however, this effect is lessened, and the results of experiments conducted with the subsequent addition of liquid Na differ little from those where all the Na is initially added. As regards the fractional composition of the sponge, the authors' data indicate that Ti conglomerates somewhat more in the finer fractions at 650 - 750° than is the case in reductions carried out at >800°, the respective contents of the >30-mesh fraction being 55 % and 64 %. But on the addition of the reducer at 650 - 750° in the first half of the process -- and at >800° in the second period -- the fractional composition is the same as in tests

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performed solely at the latter temperature. There also appears to be little difference in the fractional composition of sponge produced at high temperatures in the laboratory and sponge taken from the sides and center of industrial reactors. The study of the temperature distribution at three different levels in the reactor shows that the gaseous phase at first has the highest temperature; however, it falls well below the temperature of the reaction products towards the end of both the first and second stages of the process. The authors hence conclude that in low-temperature reactions the reduction proceeds through the intermediate layer of the titaneous chlorides. Above 800° this layer expands, and the gradual reduction of the $TiCl_4$ by Na occurs chiefly in the gaseous phase. Processes of the prereduction by Na of the titanous chlorides dissolved in molten NaCl obtain a considerable development at the very end of the reaction. There are 4 figures and 1 table.

S/598/61/000/006/009/034
D228/D303

AUTHORS: Ogurtsov, S.V., Reznichenko, V.A., Karpenko, O.A., and Yegorov, S.I.

TITLE: The two-stage method of the sodiothermic preparation of titanium

SOURCE: Akademiya nauk SSSR. Institut metallurgii. Titan i yego splavy. no. 6, 1961. Metallotermiya i elektrokhimiya titana, 60 - 67

TEXT: In re-examining the two-stage method for the sodiothermic production of Ti the authors' aim was to secure information on the optimum temperature conditions for the formation of "black salt"- $13NaCl \cdot 3TiCl_3 \cdot 2TiCl_2$; the distribution of the reaction products during the prereduction of this compound; the influence of both the rate of Na input and the excess of NaCl on the crystallization of Ti; and the main structure of the resulting metal. "Black salt" crystallizes in one of the lower systems, and has a refractive-index and melting-point of 1.66 - 1.68 and 502 - 503° respectively;

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The two-stage method of the ...

it arises as an intermediate product in the first stage of the sodiothermic process and eliminates the formation of finely-dispersed Ti -- a possible source of metal contamination. The work was done in a laboratory reactor fitted with a distillation crucible and a feeder for the liquid reducing-agent which was added either rapidly (in 1 or 2 portions) or slowly in small successive increments. The experimental data show that a homogeneous crystalline mass of "black salt" may be obtained in all cases, particularly at 750 - 850°. The simultaneous addition of all reagents gives a fine sponge. But coarser dendritic material -- with crystal dimensions of up to 25 mm and having the properties of "iodide" Ti (H_B = 90) -- is formed on the addition of liquid Na to molten "black salt" at 650 - 750°. The slow rather than the rapid addition of Na also promotes the growth of coarser Ti. Structures identified by the authors include compact sponge consisting of a homogeneous mass of small grains, dendritic material, and acicular material with discrete Ti crystals whose size is increased by decreasing the rate of the reducer's input. However, in the event of an excess of NaCl over the amount required for the formation of "black salt", the rapid addi-

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D228/D303

The two-stage method of the ...

tion of the reducer is conducive to the development of large crystals. The author conclude that the further elaboration of this method could lead to both the decreased consumption of Na and Cl in the sodiothermic process and the considerable improvement of the quality of the end-product. There are 4 figures.

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S/598/61/000/006/015/034
D245/D303

AUTHORS: Reznichenko, V.A., Lukashin, V.I., and Solov'yev, V.I.

TITLE: Aluminothermy of titanium slags

SOURCE: Akademiya nauk SSSR. Institut metallurgii. Titan i yego splavy. no. 6, 1961. Metallotermiya i elektrokhimiya titana, 104 - 115

TEXT: The reduction of Ti slags with molten Al to yield crude Ti-Al alloys was investigated. Experiments in reducing TiO_2 with excess Al to determine the effect of an excess of reducing agent on the completion of reduction and the extent of Ti extraction from TiO_2 were carried out. It is shown that excess of Al increases Ti yield. While the reaction of TiO_2 with Al is exothermic, the heat developed is insufficient to promote the reaction and it is shown that an intensive reaction requires a temperature of 1450°C. Addition of CaO as flux does not affect the Al or Ti contents of the resulting alloy. The proportion of CaO added should be 35-38 % of slag, i.e. sufficient to ensure formation of a high-temperature Ca

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D245/D303

Aluminothermy of titanium slags

aluminate eutectic. TiO_2 content in the slags used in the experiments varied from 45 - 90 %. Reduction of the Ti oxides in slag with Al began spontaneously in the temperature range 1180 - 1250°C. Chemical analysis showed that 50 % of the TiO_2 at this temperature level, remained unchanged, 35 % was reduced to TiO, 5 % to Ti_2O_3 and 10 % to Ti metal which formed a solution with excess Al. The Al content of the alloys obtained varied between 23 and 55 wt. % which corresponds to the TiAl-$AlTi_3$ section of the Ti-Al equilibrium diagram. 13 experiments were carried out in an arc furnace of [illegible] kw to produce crude Ti. Melting was carried out with solid Al heated to 600°C or molten Al as reducing agent. With solid, heated Al, the reaction was rapid: With molten Al, the reaction was slow, only slag was produced and Ti recovery was 52 - 56 %. Electrolytic refining of the anode charge prepared from the crude alloy mixed with Tu wastes etc., to obtain Ti sponge in the cathode residue was also studied. There are 11 tables.

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REZNICHENKO, V.A.; LUKASHIN, V.I.; SOLOV'YEV, V.I.

Aluminothermy of titanium slags. Titan i ego splavy no.6:104-115 '61. (MIRA 14:11)

(Titanium--Metallurgy) (Aluminothermy)

S/598/61/000/006/023/034
D245/D303

AUTHORS: Khronov, A.D., Lukashin, V.I., and Reznichenko, V.A.

TITLE: Producing titanium and titanium alloys by refining crude anodes

SOURCE: Akademiya nauk SSSR. Institut metallurgii. Titan i yego splavy. no. 6, 1961. Metallotermiya i elektrokhimiya titana, 169 - 179

TEXT: The authors studied the electrolytic refining of binary Ti-Al alloys with Al contents of 4 - 40 % in order to find the optimum conditions for refining crude Ti alloys. Since the main component of the impure Ti obtained from ilmenite concentrates is Al, the behavior of Al during electrolysis was considered to be of particular interest. The electrolyte used was NaCl; in some experiments, up to 3 % lower Ti chlorides were added. It is shown that, with an alloy with 4.2 % Al, and low current density (0.45 amp/cm^2) the Al content of Ti can be reduced to 0.15 %. Comparison of tests on refining pure Ti-Al alloys with crude Ti containing both Al and other

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impurities showed that the latter reduce the electrochemical activity of the Al present. This is attributed to Fe and its effect on stabiliz[redacted] the β-phase. To study the effects of Si, 5 to 60 % of the Al was replaced by Si, at low current densities, up to 1 amp/cm^2, the cathode deposit had a higher Fe content and a lower Al content than was found at higher current densities. Chemical analysis of fractions of the deposit showed that larger crystals had a lower Al content than smaller ones. Crystal growth is continuous throughout the refining process and, after an hour of the process, reductions of current efficiency and of e.m.f. are observed. There are 2 figures, 7 tables and 4 references: 3 Soviet-bloc and 1 non-Soviet-bloc. The reference to the English-language publication reads as follows: R. Dean, Metal Industry, 1957, no. 9, 165 - 167.

DMITROVSKIY, Ye.B.; BURMISTROVA, T.M.; REZNICHENKO, V.A.

Improved method of utilizing leucoxene-bearing titanium ores. (MIRA 16:1)
Titan i ego splavy no.8:14-21 '62.
(Titanium ores) (Leucoxene) (Ore dressing)

REZNICHENKO, V.A.; SOLOV'YEV, V.I.

Titanium slags free from chromium oxide obtained from chromium-bearing iron-titanium concentrates. Titan i ego splavy no.8: 22-27 '62. (MIRA 16:1)
(Titanium--Metallurgy) (Chromium oxide)
(Magnetic separation of ores)

REZNICHENKO, V.A.; TKACHENKO, V.A.; MIKELADZE, G.Sh.; KARYAZIN, I.A.; KOZLOV, V.M.; NADIRADZE, Ye.M.; SOLOV'YEV, V.I.; GOGORISHVILI, B.P.; Prinimali uchastiye: PKHAKADZE, Sh.S.; METREVELI, A.I.; CHIKASHUA, D.S.; KHROMOVA, N.V.; KAVETSKIY, G.D.; TSKHVEDIANI, R.N.; ARABIDZE, T.V.

Making titanium slag in an electric closed reduction furnace. (MIRA 16:1)
Titan i ego splavy no.8:28-40 '62.
(Titanium--Electrometallurgy)

BALIKHIN, V.S.; REZNICHENKO, V.A.

Studying the electroconductivity of titanium slags. Titan i ego splavy no.8:41-48 '62. (MIRA 16:1)
(Titanium oxide--Electric properties)
(Slag--Electric properties)

BALIKHIN, V.S. (Moskva); REZNICHENKO, V.A. (Moskva)

Electrochemical separation of titanium-aluminum alloys. Izv. AN SSSR. Otd. tekh. nauk. Met. i topl. no.2:49-55 Mr-Ap '62. (MIRA 15:4)

(Titanium-aluminum alloys--Electrometallurgy)
(Potentiometric analysis)

S/180/62/000/002/003/018
E091/E135

AUTHORS: Balikhin, V.S., and Reznichenko, V.A. (Moscow)

TITLE: Electrochemical separation of titanium-aluminium alloys

PERIODICAL: Akademiya nauk SSSR. Izvestiya. Otdeleniye tekhnicheskikh nauk. Metallurgiya i toplivo, no.2, 1962, 49-55

TEXT: In order to study the possibility of separating Ti and Al by means of electrolytic refining, the authors measured the potentials of Ti and Al electrodes, functioning both as cathodes and anodes. NaCl was fused in a graphite crucible placed in a stainless steel sleeve, and the electrodes were immersed in it. One electrode was of steel, and was lowered directly into the melt, while the other, upon which measurements were made, was enclosed in a quartz test tube to effect maximum separation between the electrolyte in its vicinity and the body of the melt. The test tube had an opening of 2 mm diameter for the passage of current. The Ti electrode consisted of a

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cylinder, 6 x 50 mm. It was attached to a steel wire and lowered into the melt to a depth of 10 mm below the surface. The Al electrode consisted of a graphite rod suspended in a quartz test tube of 16 mm diameter, containing molten aluminium. The working surface of each of the electrodes was 2 cm^2. Prior to measuring the potentials, the electrode under investigation was anodically polarised for a period of time necessary to ensure the required Ti or Al ion concentration in the melt of the cell. These concentrations were checked before each test by means of calorimetric analysis. Electrode potentials were first measured under conditions of anodic polarisation, with current densities varying from 0 to 1 A/cm^2 and down to zero again. The behaviour during cathode polarisation was subsequently investigated in a similar manner. Each cycle of measurements lasted approximately 5 minutes. For the measurement of electrode potentials, a silver reference electrode was used. To maintain electrical contact between the electrolytes in the cells investigated and the reference electrode, without allowing them to mix, the latter was jacketted

by two test tubes possessing openings of 1 mm diameter covered with asbestos diaphragms. The outermost of these was made of graphite, in order to protect the inner quartz tube from attack by metallic sodium which was evolved at the cathode, and also to create an additional obstacle to the mixing of the electrolytes. Thus the authors measured the e.m.f. of the cell $Ag^+/NaCl$, AgCl (5%)/NaCl/NaCl, $MeCl_x/Me^-$ at 870 °C, under conditions both of electrolysis with various current densities, and without polarising action (i.e. under conditions approaching those of equilibrium). A low frequency electron oscillograph was used as the measuring instrument. The solubility of $AlCl_3$ in molten chlorides was studied by an electrolytic method, using the same apparatus as that used for the determination of potentials but without reference electrode. Aluminium, placed at the bottom of a double-walled quartz test tube, was anodically dissolved in the molten salt, using a current of 2 A. Molten lead was used as the cathode. The current was supplied through graphite rods. The anode and cathode compartments communicated through an opening of 3 mm diameter made in the walls of the test tubes.

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Argon was passed into the test tube containing the Al in order to provide an inert atmosphere and to remove $AlCl_3$ vapours. After definite periods of time, samples of the electrolyte were withdrawn for determination of their Al content. Synthetic alloys were used for the study of the separation of Ti and Al. Melting was carried out in an arc furnace with a tungsten electrode, in an atmosphere of argon at 0.5 atmospheres pressure. Binary alloys, containing between 5 and 60% Al at intervals of 5%, were electrolytically refined. Electrolysis was carried out at 770 °C, using a current of 8 A (cathode C.D. = 1.3 A/cm^2, anode C.D. = 0.1 A/cm^2) for one hour. It was found that Ti and Al cannot be effectively separated by means of electrolytic refining in molten sodium chloride baths. However, the solubility of $AlCl_3$ in chlorides which do not form complex compounds with it is only a few hundredths of 1%, and experience with the refining of Ti-Al alloys has shown that electrolytic separation of these metals can be based on the low solubility of $AlCl_3$ in a melt of $CaCl_2$. There are 3 figures and 4 tables.
Card 4/4 SUBMITTED: December 14, 1961

REZNICHENKO, V.A.; SIDORENKO, G.D.

Studying processes occurring during the sintering of perovskite-titanium-magnetite concentrates. Titan i ego splavy no.8:62-71 '62. (MIRA 16:1)

(Sintering) (Titanium ores)

REZNICHENKO, V.A.; SIDORENKO, G.D.; EPSHTEYN, Z.D.; MARKIN, A.A.; SKRIPCHUK, V.S.

Pilot plant investigation of the blowing of titanium-niobium cast iron. Titan i ego splavy no.8:72-85 '62. (MIRA 16:1)
(Cast iron--Analysis) (Slag--Analysis)
(Oxygen--Industrial applications)

S/598/62/000/008/001/009
D217/D307

AUTHORS: Pomerantseva, A.V. and Reznichenko, V.A.

TITLE: On the composition of the mixture of rare earth elements separated from perovskite

SOURCE: Akademiya nauk SSSR. Institut metallurgii. Titan i yego splavy. no. 8. Moscow, 1962, Metallurgiya titana, 86 - 88

TEXT: No data concerning the rare-earth-metal contents of perovskite concentrates are available, and an investigation was undertaken in order to rectify this deficiency. The authors first determined the cerium and thorium contents (50.7 and 2.1 %, respectively). The remaining rare earth elements were found after the separation of Ce (as the main component) and Th from the residual trivalent lanthanides. The procedure is described in detail. The results of qualitative spectral analysis show that the composition of the rare earth product is analogous

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On the composition ... S/598/62/000/008/001/009
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to that of the rare earth concentrate separated from loparite. It was found that the application of fractional precipitation with dilute ammonia enables the following to be separated in one operation from a mixture of rare earth elements obtained from a perovskite concentrate: Ce, Th, La in the pure state, and a mixture of the Ce and Y group, in which the Ce subgroup with La as an impurity prevails.

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S/598/62/000/008/007/009
D217/D307

AUTHORS: Mirochnikov, V.S. and Reznichenko, V.A

TITLE: Extraction of metallic titanium from cathode deposits produced by the electrolysis of K_2TiF_6 - NaCl - TiO_2 melts

SOURCE: Akademiya nauk SSSR. Institut metallurgii. Titan i yego splavy. no. 8. Moscow, 1962. Metallurgiya titana, 214 - 219

TEXT: The metal losses incurred in the extraction of Ti were estimated and the influence of hydrometallurgical treatment on the quality of the metal was investigated. It was found that the cathode deposit could be treated with acid without any deterioration in the properties of Ti (the O_2 content of the metal decreases): however, a considerable loss of metal occurs. The latter is due to chemical attack by HF which if formed according to the following reaction:

$$K_2NaTiF_6 + 3HCl = 2KCl + NaCl + TiF_3 + 3HF.$$

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Extraction of metallic titanium ... D217/D307

The losses of metal can be reduced by preliminary enrichment of the cathode deposit with respect to its metal content, or by the addition to the melt of agents capable of reacting with HF to form soluble compounds. There are 2 figures and 2 tables.

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REZNICHENKO, V.A.; SOLOMAKHA, V.P.

Chlorination of calcium metatitanate. Titan i ego splavy no.8:89-97 '62. (MIRA 16:1)
(Calcium titanate) (Chlorination)

MELENT'YEV, B.N.; MOINOV, S.G.; REZNICHENKO, V.A.

Obtaining titanium dioxide by the interaction of titanium tetrachloride with oxygen. Titan i ego splavy no.8:114-118 '62. (MIRA 16:1)

(Titanium oxide) (Titanium chloride) (Oxygen)

IRKOV, F.Ya.; REZNICHENKO, V.A.

Obtaining titanium dioxide by the treatment of slags from the smelting of titanium-magnetite sinters. Titan i ego splavy no.8:119-123 '62. (MIRA 16:1)
(Titanium oxide) (Hydrometallurgy)

OGURTSOV, S.V.; REZNICHENKO, V.A.; DEDKOV, A.I.

Standardization, intensification, and automatic control of the thermochemical reduction process with magnesium. Titan i ego splavy no.8:145-159 '62. (MIRA 16:1)
(Titanium--Metallurgy) (Automatic control)

S/598/62/000/008/003/009
D217/D307

AUTHORS: Batashev, V.I. and Reznichenko, V.A.

TITLE: The refining of titanium

SOURCE: Akademiya nauk SSSR. Institut metallurgii. Titan i yego splavy. no. 8. Moscow, 1962, Metallurgiya titana, 167 - 174

TEXT: The nature of certain processes taking place during the iodide refining of Ti may be exploited in an attempt to raise the purity of Ti with respect to metallic impurities and silicon. The characteristics of the iodide refinement under conditions in which the reactions leading to a higher purity of Ti iodide can be controlled, may also be identified. It is shown that a decrease in the rate of sublimation of Ti tetraiodide in vacuo is accompanied by a decrease in the Mg, Al, Si and Fe contents of the Ti iodide. Kinetic factors are likely to influence the transfer of impurities by the stream of Ti tetraiodide produced during evaporation of the latter. It is found that the purity of TiI can be increased

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